

JPRS: 18,208

OTS: 63-21356

19 March 1963

AD No. 405241

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TRANSLATIONS FROM

NAUCHNYYE DOKLADY VYSSHEY SHKOLY: FILOSOFSKIYE NAUKI

(Higher School Scholarly Papers: Philosophical Sciences)

No 5, 1962

- USSR -

DDC

REF ID: A21122

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TRANSLATIONS FROM NAUCHNYYE DOKLADY VYSSHEY SHKOLY:  
Filosofskiye Nauki

- USSR -

[Following is the translation of two articles from the Russian-language publication Nauchnye Doklady Vysshey Shkoly: Filosofskiye Nauki (Higher School Scholarly Papers: Philosophical Sciences), Moscow, No 5, 1962. Additional bibliographic information accompanies each article.]

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## THE INTERRELATIONSHIP BETWEEN TWO ASPECTS OF COGNITION

Following is the translation of an article by B. N. Kedrov in Nauchnyye Dokladы Vysshey Shkoly: Filosofskive Nauki (Higher School Scholarly Papers: Philosophical Sciences), Moscow, No 5, 1952, pages 42-46.

[50-58]

[v 5]

[q. 2]

### 1. The Effect "mechanism" of Object on Subject

1. The relationship between the empirical and theoretical in science, that is between facts and their explanations, cannot be examined without considering various facets of the object of study, constituting an object existing outside and independent of the consciousness of the investigator himself. This means that from the very beginning in an analysis of a given problem a basic gnoseological question arises -- that of the relationship between the subject (S) and object (O), between the process of cognition and the object of cognition:  $\rightarrow$  (the fat horizontal line signifies the relationship of S to O). We limit ourselves in this paper to an explanation merely of the effect "mechanism" of object O on subject S, ignoring a no less important question dealing with the reverse effect of the subject on the object in the cognition process and the practical activities of man.

2. The entire history of science indicates that beyond direct phenomena (p) are hidden their essence (E), that is the laws (L), causes, the internal "mechanism" of the processes "structure" of things. The essence of phenomena has not been given to us directly, for it is concealed in phenomena and beyond phenomena; therefore it must be discovered, revealed, and penetrated. The problem of scientific cognition consists in discovering the laws of phenomena and mastering them. Such a presentation of the problem makes it possible to reveal two contradictory facets of the object (O) and present the process of cognition as a movement from phenomena (p) to their essence (E), or to their laws (L):



Figure 1

(the fat line indicates the direction of cognition from one side of the object (phenomena) to its other side -- to essence (E) or laws (L). The rectangle contains the area of the object).

3. There is no barrier between essence and phenomenon, and there is no basic cleavage other than our temporary ignorance of what is concealed behind direct phenomena. The essence of a thing is fully presented, without anything left over, in the phenomenon of this thing. Everything which exists in essence makes the shift to phenomenon and appears in it. Therefore in studying the phenomenon we can perceive its entire essence. The opposite viewpoint (Kantian) is as follows: between phenomenon (p) and essence (E) there is a basic borderline, hindering the cognition of the essence of things. We call such a viewpoint agnosticism.

4. The process of object cognition begins with a study of phenomena constituting the external manifestation of the object, or its exterior, so to say its surface. The effect of the object (in the form of phenomena) on the subject and on its senses furnishes the empirical material to science, the data of sense cognition. This effect can be direct, indirect, or occur through the medium of some physical device, measuring instrument, etc. Empirical data of and by themselves, as they are established in the process of sense cognition, are not interconnected; they are discrete. They represent the initial atoms or building bricks of that material of which the structure of science is built. We call such discrete empirical materials facts. Consequently fact is a bit of objective reality established by us empirically. We shall designate the process of the effect of various phenomena (p) on the senses (s) of the subject with light arrows, and with heavy dots -- the discrete empirical material (e) established as a result of this effect, that is fact (f):

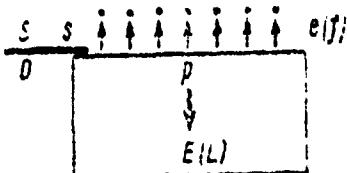


Figure 2

Here we reveal the inner "mechanism" of the effect of the object (O) on the subject (S) at the initial point of cognition.

5. Since phenomenon (p) contains within itself everything which exists in essence (E), but only contains

this "everything" in an obscurely expressed, concealed form, then the facts ( $f$ ) and the empiricism ( $e$ ) contain their concealed general relationship, expressing the law of the objective phenomena themselves. It is the problem of science to elucidate the concealed relationship between the facts, "to read the Bible of the senses in the relationship" (Feuerbach), that is make this relationship clear and studiable. Scientific cognition reaches its goal by unification or synthesis of facts. Such a problem cannot be solved by purely empirical methods and means. Here abstract thought ( $t$ ) is essential, a theoretical approach is necessary, and logic ( $l$ ) as well. Relying on the devices of logic, theoretical thought synthesizes facts, forms at first their presupposed explanations, hypotheses ( $H$ ), then theories ( $T$ ), based on a knowledge of the essence ( $E$ ) of the object and its laws ( $L$ ). (see Figure 3).

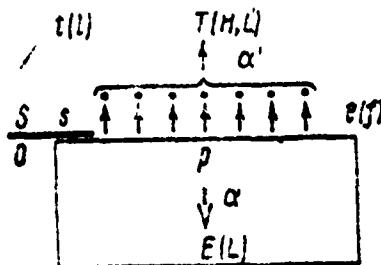


Figure 3

Here parenthesis means the unification or synthesis of disparate discrete empirical data (facts), bringing them into relationship with the aid of theoretical ( $t$ ), logical ( $l$ ) thought; the upper light arrow indicates that synthesis of the facts leads to the formation of theories ( $T$ ) and hypothesis ( $H$ ), to the discovery of laws ( $L'$ ). The difference between  $L$  and  $L'$ , as well as the meaning of symbols  $a$  and  $a'$  will be explained below.

6. The concept "law" has a dual meaning. It means:  
 1.) the law of the external world (nature or society) as the expression or fraction of the relationship of its phenomena ( $L$ ) and 2.) the law of science ( $L'$ ) as an expression in the consciousness of the subject of the objective law ( $L$ ) of nature or society. Objective laws therefore serve as the content of the laws of science. But since science is not a sum total of absolute truths or exhausted knowledge, its laws are always relative in the sense that they express the objective laws of the phenomena of the world not fully but only partially, approximately. Therefore scientific knowledge of the laws of the world never corresponds fully with

the laws themselves, existing outside and independent of the subject. Man can neither create, destroy, nor alter objective laws. Knowledge of these laws changes constantly. The breakup of old and elaboration of new formulations of scientific laws under the influence of scientific progress may create the false impression that in this process old laws of the actual world are being broken up and new ones are being established. Actually, only change and development, breakdown and rebuilding of the knowledge of man in respect to the laws of the external world occur.

7. Transition from empiricism (e) to theory (T), from facts to their synthesis is not arbitrary. It cannot be effected by any given method. This transition is achieved only in a strictly determined, although not exclusive, manner. It is determined not by the peculiarities of the subject and his cognitive capabilities, but by the nature of the object and primarily by the relationship between its two contradictory facets: phenomenon and essence. Since essence and a relationship between phenomena conforming to certain laws are one and the same, discovery of an inner relationship between facts signifies penetration into the essence of phenomena, which contains within itself this relationship. Consequently, movement of cognition from empiricism (e) to theory (T) is its movement from phenomena to essence:  $e \rightarrow T = p \rightarrow E$ . The symbols a and a' designate in essence one and the same method of shift of cognition from one stage of its existence to another, higher stage, viewed either from the peculiarities of the cognitive actions of the subject (a'), or from the various facets of the object (a). Phenomenologium occurs where the tasks of science are artificially limited merely to a description of phenomena, consequently when the function of penetrating into their essence is removed.

8. Customarily in neo-positivist literature recognition of the existence of something beyond the limits of human sensations is called metaphysics. Subjectivists deny that anything at all can exist outside man and his senses, while agnostics assert that if something does exist, it cannot be cognized. Maintaining these positions it is impossible to understand the essence of the process of cognition. It is absolutely inexplicable why the transition from empiricism (e) to theory (T) is effected in this manner and not in any other. Actually we are forced to recognize that the transition from empiricism (e) to theory (T) is determined by the movement of cognition from one (external) side of an object to the other (inner) side, that is that this transition is determined by a deepening of cognition from phenomena to essence. We call metaphysics any artificial split in the single interconnected process of cognition, any introduction into it of artificial partitions, any dogmati-

zation and absolutization of individual scientific principles, any cleavage of one facet of cognition from the process of cognition as a whole, for example through remaining with empiricism, with a bare description of facts. Thus the "mechanism" of the interrelationship of subject with object at a higher stage of cognition is determined in the final analysis by the peculiarities of the object, existing outside and independent of the subject. There is nothing metaphysical (in our meaning of the word "metaphysics") in this explanation.

## II. The Multi-Stage Essence and the "Mechanism" of Revealing It

9. We shall now examine the following problem: how does the development of scientific theories, their elaboration, the replacement of certain less developed by perfected theories take place? What is the inner "mechanism" of this cognition process? We shall attempt to furnish an answer to this question, proceeding from the same principle on the relationship between the subject (S) and object (O), which we used above as our guide.

10. We will begin here with an examination of various facets of the object. In this respect of great importance is the fact that the essence of things and phenomena is not simple, ordinary nor homogeneous, but complex, multi-aspect, as if multi-layered or multi-storied. Therefore the shift from phenomenon to essence cannot be completed in one action, with one simple stride of cognition, but constitutes a lengthy historical process, temporally infinite; therefore science itself is infinite. If the essence of things and phenomena is "multi-storied", this establishes a definite sequence in shifting cognition from one "story" to another, then to the following, etc. Figuratively speaking the movement of cognition in this respect is similar to an elevator: it is impossible to rise directly from the first floor to the top, bypassing the second, third, etc. The same thing occurs in the process of cognition: The essence of a thing or phenomenon is revealed not immediately, totally and fully, but only gradually, step by step, stage by stage, "story" by "story". We shall designate with ordinal numbers beginning with the first stage of essence (E), and with the symbols alpha, beta, gamma, delta, etc. -- subsequent transitions from phenomena to essence of the first order (alpha) and further from essence of the first order, less profound, to essence of the second order, more profound (beta), from it to essence of the third order, even more profound (gamma), etc. In this case the object under study (O) will appear as a unique multi-story structure (see Figure 4).

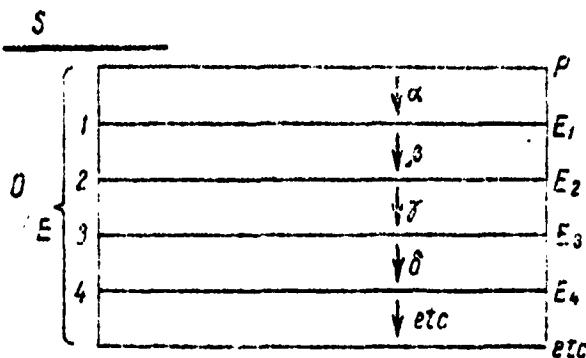


Figure 4

11. The history of modern atomism serves as an excellent illustration and convincing proof of such a multi-layer or multi-stage nature of the essence of physical and chemical phenomena. At first chemists and physicists studied only named phenomena, amassing the essential experimental material for establishing their science. When at the beginning of the nineteenth century Dalton not only explained but predicted and later discovered experimentally stoichiometric relationships in chemistry, he relied on concepts of atoms. This was the transition from chemical phenomena (p) to essence of the first order ( $E_1$ ):  $p \rightarrow E_1$ . In 1869 Mendeleev discovered the periodic law of chemical elements; this was a first step toward penetrating the essence of the atoms themselves, which was an essence of the second order ( $E_2$ ):  $E_1 \rightarrow E_2$ . When Thompson discovered the electron, penetration began deep into the atoms themselves, into their electron mantle. Later Bohr built a model of an atom; due to this the physical essence of the periodic law as an essence of the third order ( $E_3$ ):  $E_2 \rightarrow E_3$ , was discovered. An even deeper essence, connected with penetration into the atomic nucleus, began to be revealed after Chadwick discovered the neutron (1932):  $E_3 \rightarrow E_4$ . Finally, recently the penetration of physics began into the neutron and other "elementary" particles, that is into an even deeper essence. The path traveled by cognition can be expressed in summary as follows:

$p \rightarrow E_1 \rightarrow E_2 \rightarrow E_3 \rightarrow E_4 \rightarrow \text{etc.}$

12. In respect to phenomena subsequent stages of deepening essence occur in a dual manner: 1) either a deeper and deeper essence of one and the same phenomenon is revealed ( $p_1$ ), 2) or a deeper essence is revealed through new, formerly unknown phenomena of a more complex nature ( $p_2, p_3, \text{ etc.}$ ). As a rule in the history of scientific cognition both paths for going deeper into the essence interweave, accompany each other and affect each other. The general "mechanism" for penetrating into the essence of phenomena is represented schematically in Figure 5.

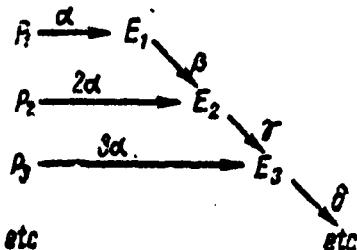
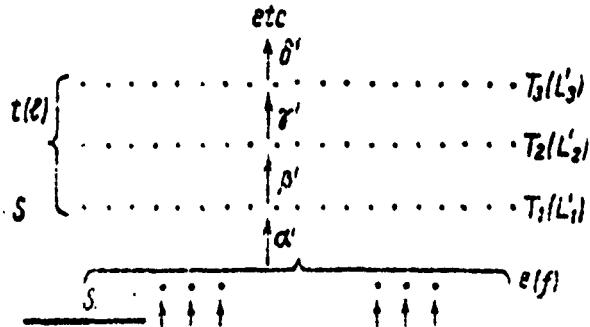


Figure 5

Here the symbol  $2\alpha$  represents the direct transition from phenomena  $p_2$  to essence  $E_2$ ; correspondingly  $3\alpha$  signifies the transition of  $p_3 \rightarrow E_3$ , etc. The arrows indicate the possibility of a dual transition from essence of the first order ( $E_1$ ) of phenomenon ( $p_1$ ) to essence of the second order ( $E_2$ ) of the same phenomenon ( $p_1$ ): 1) according to the scheme  $p_1 \rightarrow E_1 \rightarrow E_2$  and 2) by the schemes  $p_1, p_2 \rightarrow E_2$ . In the actual historical process the movement of cognition from phenomena deep into their essence occurs in an even more complex manner, since essence of the second order ( $E_2$ ) is simultaneously essence of the group of phenomena corresponding to it ( $p_2$ ), as well as a deeper essence relative to simpler, initial phenomena ( $p_1$ ). The scheme of this more complex case combines both preceding ones:  $p_1 \rightarrow E_1 \rightarrow E_2$  ~~as~~  $p_2$ .

13. Chemistry provides us with an example of the first method of penetrating deep into essence. Chemical phenomena (reactions and transformation of matter) have been known for a long time. At the beginning of the nineteenth century they were treated by Dalton and earlier by Boyle and Lomonosov) as the joining and dissociation of atoms: in the second half of the nineteenth century and structural theory -- as the formation, saturation or rupture of valence bonds; later in electronics by Kossel' and L'is) -- as interaction (bias, detachment or capture of valence electrons); finally, in the second quarter of the twentieth century in quantum mechanics -- as the interaction of electrons (electron clouds) possessing specific spin values. An example of the second method of penetrating deep into the essence is provided by atomic physics. In order to penetrate deep within the atom it was necessary to discover electrons and the atomic nucleus as structural atomic particles. This was preceded by the discovery of the phenomenon of radioactivity by Becquerel (1896). In 1902 Rutherford and demonstrated that its essence consists in atomic disintegration. Developing this doctrine further, Rutherford discovered the atomic nucleus and went deeply into it, creating nuclear physics. The combination of both methods is seen in the first example: discovery of a new group of physical phenomena ( $p_2$ ), leading to the discovery of electrons, including valence electrons, exerted direct influence on further progress into the nature of chemical phenomena ( $p_1$ ).

14. In accordance with the movement of cognition deep into the multi-stage-multi-layer essence of things and phenomena, that is the structure of the object, scientific theories develop. Penetration into deeper essence usually causes a radical breakdown of old theories ( $T_1$ ), which up to that time have been based on a knowledge of its shallower essence, and the creation of new theories ( $T_2$ ), which more fully and accurately reflect the nature and laws of a given group of phenomena (object), based on the knowledge of its deeper essence. We thus reveal a more detailed "mechanism" of interaction between subject (S) and object (O):



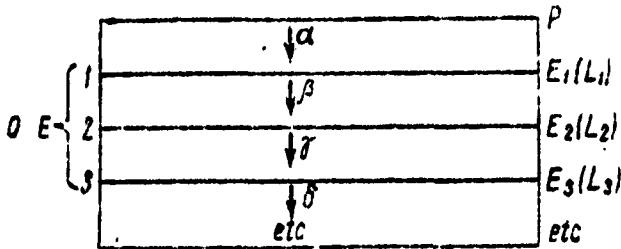


Figure 6

The area of cognition or of the subject (S), reflecting transitions from its empirical to theoretical aspect, depicts the transition from one, more superficial, side of the object (O) to another, deeper side, whereby transitions in the area of the subject (S) correspond exactly to transitions in the area of the object (O). This is the most highly developed form of the effect "mechanism" of the object on the subject. Here we are abstracting ourselves not only from the reverse active effect of the subject on the object during the process of its practical activities, but also from the reverse transition from theory to empiricism, which is continuously going on in the process of scientific cognition, when theoretical concepts point out the way for further empirical research.

15. Comparing both profiles (or aspects) of the movement of scientific cognition -- from phenomena (P) to essence (E) and from empirical (e) to theoretical (T), we can put together the following diagram:

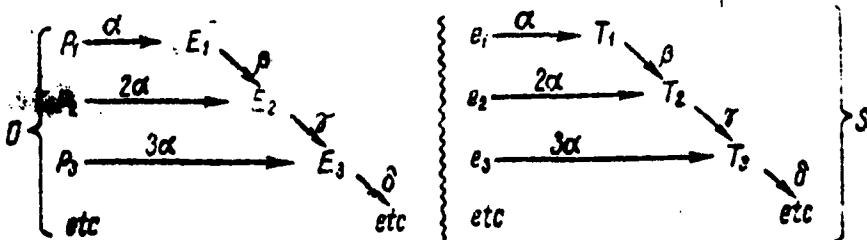


Figure 7

Here the symbol indices of the right section of the diagram signify the sequential accumulation of new empirical material ( $e_1, e_2, \dots$ ), synthesized in theories replacing one another in sequence ( $T_1, T_2, \dots$ ); transition from the empirical material to its theoretical synthesis ( $a'$ ), just as transitions from old theories to new ( $b', c', d', \dots$ ), correspond to a deepening of cognition in the essence of the object being studied ( $a, b, c, d, \dots$ ).

16. The history of science shows us how new theories

are formed with each transition from phenomena to essence and from essence of the first order to essence of the second, higher order. An example is the synthesis of empirical data in classical Newton mechanics and transition from it to quantum mechanics and the theory of relativity in physics. Here it is important that essence of the highest order ( $E_2$ ) includes within itself essence of the lowest order ( $E_1$ ), constituting its development. Simplifying with the aid of abstraction our knowledge of deeper essence ( $E_2$ ), we can mentally make the reverse journey and "return" to shallower essence ( $E_1$ ). Correspondingly, from a more complete theory ( $T_2$ ), founded on the knowledge of a deeper essence of phenomena, we can mentally make the transition upon stipulating specific conditions to a less complete theory ( $T_1$ ), based on the knowledge of shallower essence ( $E_1$ ) of the same phenomena. This signifies that any new, more complete theory ( $T_2$ ) includes within itself the rational content of the former theory ( $T_1$ ) as its extreme or particular case. This regular correspondence between old and new theories in physics was formulated by Bohr (1913) in the form of the "principle of correspondence". In stipulating specific conditions relativity and quantum mechanics (particularly quantum statistical) relationships regularly make the transition to classical. The philosophical significance of the principle of correspondence consists in the fact that it reveals the internal "mechanism" of the accumulation of grains of absolute truth (that is total knowledge of the object) in the process of sequential transition from the one, less complete and full relative truth to another, fuller and more comprehensive, but also relative truth. This was demonstrated by Kuznetsov (1948).

17. A radical breakdown of old theories and related concepts constitutes a genuine revolution in science. It is not caused by a new fact per se (for example, the discovery of a new substance), but by the creation of a new theory, the formulation of a new interpretation of facts, incompatible with previous theoretical concepts in science. For example, the purely empirical discovery of oxygen per se did not cause a revolution in chemistry. In addition, Priestly made this fact compatible with the phlogiston theory. The revolution in chemistry began when Lavoisier created the oxygen theory and proved the falseness of the phlogiston theory. Just like the revolution in physics, radium caused a revolution only when the theory of radioactive disintegration was born.

18. All transitions in the development of science from empiricism to theory and from one theory to another, noted above by the symbols  $a'$ ,  $b'$ ,  $g'$ , etc., constitute a revolution in science or stages of one and the same revolution. They occur in the following manner: first within the limits of one and the same aspect of cognition, correspondingly --

of the essence of one and the same order, a quantitative accumulation occurs of new empirical data, new facts, which per se do not yet cause any revolution in existing views. Then the time comes when the qualitatively increased experimental material no longer lodges within the framework of existing views. Then more or less suddenly and sharply obsolete views crack through their foundations; qualitatively new views take their place, theoretically able to embrace and synthesize all experimental material -- both that which was accumulated previously and serves as a basis for the old theories, but particularly that which appeared later, outside their framework. Revolution in science is therefore a leap from one stage of cognition corresponding to essence of one order, to another stage of cognition, corresponding to essence of a higher order.

19. The following revolutions took place in the natural sciences: the overthrow of the geocentric system of Ptolemy by Copernicus and the creation of a new, heliocentric system in the sixteenth century, the rejection of the doctrine of weightless fluids and the discovery of the law of preservation and transformation of energy in the nineteenth century by Meyer and others, breakdown of the concept of the permanent form and conception of teleologism in biology and the formulation of the theory of evolution by Darwin. A great revolution in philosophy and the social sciences was brought about by the teachings of Marx.

As an example of development by stages we can use the "latest revolution in natural sciences", as Lenin called it. It began at the end of the nineteenth and beginning of the twentieth century; its first ("electronic") stage continued during the first 25 years of the twentieth century. In the 20's the second stage began, brought about by quantum mechanics, as well as the theory of relativity previously formulated by Einstein; the "quantum-relativity" stage continued until the end of the 30's. But already at the beginning of the 50's, simultaneously with it, the third stage of the same revolution began to be born, along with the successes in nuclear physics. The leap forward here was the theoretical interpretation of a phenomenon occurring during the action of neutrons on the uranium nucleus -- nuclear fission. Presently this "nuclear-physical" or "atomic energy" stage has not yet terminated, but signs have already appeared as harbinger of a fourth stage in the same revolution, in connection with penetration into the "elementary" particles (nucleons, mesons, etc.), as well as in connection with the penetration of man into space, the rapid development of cybernetics, success in biochemistry and molecular biology and other achievements of science and technology. This coming stage of "the latest revolution in natural sciences" will go into full swing in the very near future.

20. We can summarize as follows: 1) breakdown of old theories begins when cognition makes a new transition to a deeper essence of the object being studied; 2) at the same time not all contained in the former theory breaks down and is rejected, but only its limitations, absolutes, ascribed to actuality, which were introduced to it by our reflection but which do not actually exist; 3) everything which was correct in the old theory, which corresponded to the object itself, is retained and maintained in the new theory, but not as something universal and all-encompassing as it appeared in the old theory, but subjugated to new and broader concepts; 4) no matter how perfect and complete a new theory may seem, it never can become the last stage, exhausting the entire object of research, that is it cannot constitute an absolute truth in a total sense. The essence of the object is infinite and inexhaustible, constituting an infinite number of stages, passing deep into any object of study. Therefore science is infinite in its movement toward truth, and man can never say: "Period! I have learned everything, right up to the end!"

21. We will end where we began: it is impossible to comprehend the relationships between the theoretical and empirical aspects or facets of science, scientific cognition, ignoring the correlation between the aspects of the object itself, and not elucidating the effect "mechanism" of the object on the subject. The key to understanding the interrelationship between these aspects of science and their unique nature provides a gnoseological analysis of the problem of relationship between subject and object. The author has attempted to make such an analysis from the position of materialist dialectics (in conclusion the author thanked the participants of the symposium for attentively listening to his paper and participating in the discussion, which lasted about three hours. On their part the participants of the symposium expressed gratitude to the Soviet delegation for setting up the reading of the paper, which made it possible for them to become acquainted with the views of Soviet philosophers on this question, avoiding the intermediate step of doubtful "commentators", presenting Soviet philosophy for western readers in a distorted form. In view of this the participants of the symposium expressed the wish that the works of Soviet philosophers, if even only the most important ones, be published also in English, since the great majority of American and British scientists do not know Russian, and therefore are deprived of the opportunity of becoming acquainted with these works in the original".

(at the end of August - beginning of September 1962 at Stanford University, the Third International Congress on Scientific Logic, Methodology, and Philosophy was held /The pre-

ceding Congress was held in Zurich in August 1954. The Soviet delegation included Omel'yanovskiy, Semenov and the author of this paper. On 27 August one of the sections of the Congress (on general problems of methodology and philosophy of science) held a symposium on the topic: "Theoretical and Empirical Aspects of Science". Specially invited persons, the names of whom had already been placed in the Congress schedule, could participate in the symposium. These were philosophers Melberg (USA), Bergman, (USA), Popper (Great Britain) and the biologist Budger (Great Britain), as well as Kotarbinska (Poland), who could not come. The Soviet delegation arrived by the convening of the Congress and could become acquainted with the program only on the spot, when the participants of the symposium had already been selected. Therefore they could not present their petition to participate. However it became necessary to expound their viewpoint on questions dealt with in the symposium. On agreement with the directors of the Congress it was decided to hold a factual session, at which the author of this paper made as it were an unscheduled continuation of the symposium. The purpose of this paper consisted in expounding in positive form the viewpoint of dialectical materialism on this question and presenting the opportunity to the representatives of other philosophical schools to discuss it. All participants of the symposium were invited to the facultative session, in addition to several philosophers and natural scientists: Bunge (Argentina), Kogen (USA), etc. In order to give more vitality to the discussion, it was decided to ask questions and make remarks during the course of the reading, interrupting the speaker. This made it possible to eliminate unclear points and misunderstandings arising among the listeners (chiefly dealing with terminology) in the process of the reading itself, in order to focus the subsequent discussion around the most essential questions. The article presented here is in an abbreviated form, with the use of the symbols as applied at the facultative session of the symposium (the first letters of the corresponding English words were used as symbols).

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## THE PHYSIOLOGICAL BASIS OF CONSCIOUSNESS IN THE LIGHT OF MOST RECENT RESEARCH ON BRAIN ACTIVITY

/Following is the translation of an article by  
M. A. Logvin in Nauchnyye Doklady Vysshey Shkoly:  
Filosofskiy Nauki, No 5, 1962, pages 42-49./

In the last 15 years, both in the Soviet Union and abroad, a great increase has been observed in research on the activity of the brain. As the eminent Canadian neurosurgeon Penfield puts it, "Neurophysiologists, barely breathing, are soaring upward to the unconquered heights of knowledge" (W. Penfield, "Consciousness and Centrencephalic Organization," Congress International des Sciences Neurologiques, 1957, II, Bruxelles, 1957, p. 7). This research, which is of cardinal importance for many fields of knowledge, is meeting with greater and greater interest toward the astounding activity of the human brain, its mechanisms and capabilities of efficient use of the principles of this activity for building amazing technical devices. In a philosophical sense the data obtained through this research deal primarily with the basic philosophical problem of the relationship between consciousness and matter and the basic problems of the theory of cognition. Our task is to study carefully the latest research on the brain, and, guided by the instructions of Lenin and the Party Program, to draw proper philosophical conclusions, carrying out a vigorous campaign against attempts by idealism to utilize the difficulties of cognition for anti-scientific purposes. At the All-Union Conference on philosophical problems of the physiology of higher nervous activity and psychology which took place in May of this year, it was noted that the further development of both sciences should be based on the principles of the teachings of Pavlov and that the task of an ideological fight for these principles continues and remains a vital job. The conference also appealed for the creative elaboration of vital philosophical problems in modern physiology and psychology, for a bold search for new ways of developing the science of the brain in accordance with the demands of Communist instruction.

### Brief Data on the Latest Experimental Research in Brain Activity

Major success in modern neurophysiology is due to the application of the latest achievements of physics and chemistry, sophisticated microelectrode equipment, which has made it

possible to penetrate deeper into the internal relationships of the nerve elements. The beginning of the new stage of research is usually placed at the time of the publishing in 1949 of the results of experiments by the neurophysiologists Magoon (USA) and Moruzzi (Italy) with direct electrical stimulus of the reticular formation in cats and other animals, which leads to a change in the electrical activity of the cerebral cortex. Electrophysiological research discovered new and important functions of the reticular formation and the presence of a non-specific afferent system. It was determined that branches (collaterals) pass to the reticular formation from the primary stream of certain classical specific afferent channels, before it reaches the optic thalamus. Afferent impulses received along the collaterals are then sent in a changed form to the cortex along non-specific channels. The peculiarity of impulsion passing along the non-specific system consists in the fact that, in contrast to the impulses along the specific channels, providing stimulus to comparatively limited sections of the cortex, it stimulates almost the entire cortex.

Thus any afferent stimulus passes to the cerebral cortex through two qualitatively different channels: along known specific channels and non-specific. The entire system, consisting of the reticular formation and channels leading impulses from it to the cortex, has received the designation activating reticular system. Further research, particularly by Soviet scientists (Anokhin, Narikashvili, Sarkisov et al), introduced a number of important new elements, specifying and developing the physiology of the reticular formation. It has been proved that this nerve structure is not homogeneous, that it exerts varied and differentiated ascending influence, proceeding along various channels, that the specific system does not exist isolated from the non-specific, and that the reticular formation in turn is affected by activating or impeding impulses from other nerve structures, primarily from the cerebral cortex. The latest neurophysiological research has made extremely vital the old theoretical problem of link between consciousness and brain or, as it is formulated in the West, "consciousness-brain", "thinking-brain". Two problems occupy the center of attention at symposia, congresses, in books and articles by foreign neurophysiologists: 1) the physiological basis of consciousness and 2) the nature of consciousness, and in connection with them, the problem of consciousness and brain. We shall stop briefly on the first problem.

#### The Physiological Basis of Consciousness

The problem of the physiological basis of consciousness is very important both for physiology, clinic, as well as psychology and philosophy. Essential data in this respect are

furnished by clinic, pathology, anatomy and morphology, histology and biochemistry of the brain, and in particular physiology of the brain. Recently much importance has been acquired by cybernetics, which has discovered new possibilities for cognizing the principles of the internal workings of the brain. Data obtained have proved irrefutably that the material basis, the carrier of the human mind, is the brain. Expressing the prevalent viewpoint of modern physiologists, the eminent French electrophysiologist Fessard said: "Nobody at the present time will deny the fact that there exists a nerve substratum for EI (consciousness) in the brain" (A. Fessard, "Mechanisms of Nervous Integration and Conscious Experience", Brain Mechanisms and Consciousness, Oxford, 1954, page 206).

This assertion is a great stride forward from the position of foreign physiologists who denied the existence of a nervous substratum to consciousness and the correctness of physiological study of mental phenomena and, without a doubt, constitutes a major victory for the ideas of materialism in physiology. For example, Sherrington asserted that thinking is not a product of the physiological activity of the brain and therefore we are incorrect in linking it to spacial physiological processes in the brain, and knowledge of it "is not given to analysis by biologists and physicists", that is analysis of the natural sciences *viz.* Ch. Sherrington, Man on His Nature, Cambridge, 1942, page 27. Now, as Fessard correctly notes, there are differences of opinion on the question of understanding the substratum of consciousness, the area of its localization, and we might also add: the nature of connection between consciousness, brain and the external world. It is on this problem at present that on the one hand idealistic and dualistic views occur, including those conventional ones for modern "physiological" idealism, such as in Sherrington, Ickles, Walsh, Culenbeck and Brain (Brain himself calls his concept that the primary inborn function of the nervous system consists in symbolization, "physiological idealism" *viz.* R. Brain, "The Cerebral Basis of Consciousness", Brain, A Journal of Neurology, vol. 73, part IV, 1950, pages 476-477). On the other hand, there exist mechanistic and vulgar-materialistic views, equating consciousness with nervous-physiological processes. Pavlov established that two primary mechanisms lie at the basis of the mental activity of both higher animals and man: the mechanism of temporary connection and the mechanism of analyzors. In man both mechanisms reach a qualitatively new stage in connection with the origin and development of new, specific to the human system, temporary connections, a second, speech signal system, and new laws for the interaction between the first and second signal systems. Further research has demonstrated the correctness of the Pavlovian principles of the physiological mechanisms of the mental life of man and animals. In addition, this

research introduced much new material, making our concepts of the basic mechanisms of higher nervous activity more concrete. According to modern views the reflex act constitutes a complex process of active interaction of the organism with the environment, which is not terminated with action in response to stimulus, but continues in the form of inverse afferentiation on the results of this action to the central nervous system (P. K. Anokhin). Only on the basis of such interaction does the formation of a subjective form of external phenomena take place.

Modern research is directed toward revealing what processes take place deep within the brain, up to its individual nerve cells and their interconnections. Revealing the structure and organization of internal brain processes, this research emphasizes the importance of internal factors in the brain and organism serving as a vehicle for the influence of the environment, the importance of its independent reaction force, purposeful activity, based on the realization of accumulation of both phlogenetic and individual experience fixed in the nervous structures of unconditioned and conditioned reflexes.

We shall attempt in brief to examine new concepts proceeding from data of physiology of the reticular formation for understanding the physiological basis of consciousness, critically treating erroneous conclusions formed by foreign scientists. The brain consists of various sections, structures and areas, which play different parts in the formation and activity of consciousness. Therefore it is necessary to consider the specific role of all these sections, including the subcortical formations and the entire column, guided by a dialectical comprehension of the relationship between the part and the whole. In view of this we cannot accept as correct the fact that part of our philosophical literature attributes the material basis of all higher nervous activity and all mental processes to conditioned reflex activity of the cerebral cortex. This contradicts the universally known determinations of Pavlov in higher nervous activity. The erroneous nature of a narrow comprehension of a material basis of consciousness becomes particularly obvious in the light of the latest neurophysiological research which points out the serious importance of subcortical structures in the formation and activity of consciousness and expands our concept both of conditioned reflexes and of analyzors as the physiological mechanism of reflection.

Analyzors constitute a large and complex system consisting of various levels, sections and elements, playing various roles in the total reflective process of the organism. A constituent part of the analyzors is the non-specific afferent system. Stimulus points in the reticular formation

and along the two afferent channels in the cerebral cortex constitute one functional system. In addition, the reticular formation has its own special significance in reflection activity. The end result of all nervous processes is the transformation of nerve impulses into a complex mental image, received in the cortical link of the analyzer. According to latest neurophysiological data, this image cannot form without the participation of the reticular formation (generalized cortical stimulus) in preparing essential conditions for terminating the process of completion as a basis for creating a given image (viz. Anokhin, "Successes of Modern Neurophysiology and Their Importance for Elaborating the Problems of Higher Nervous Activity", Vestnik Akademii Meditsinskikh Nauk [Herald of the Academy of Medical Sciences], 1959, No 5, p. 44).

Neurophysiological research has also ascribed vital importance to the problem of emotions. Pavlov frequently drew attention to the specific role of the lower, elementary emotions in the process of reflection. Obviously the physiological ground for these emotions is broader than the subcortical bundles, and their content has several levels and components. Hungarian neurophysiologists Lishak and Endretsi assumed that the basic role in the formation of emotional conduct is played both by subcortical mechanisms and the brain column (viz. Lishak and Endretsi, "Neurohumoral Factors in Controlling the Behavior of Animals", Zhurnal Vysshey Nervnoy Deyatel'nosti imeni I. P. Pavlova [Journal of Higher Nervous Activity imeni I. P. Pavlova], issue 3, 1960, page 333). It is a well known fact that Pavlov distinguished elementary emotions from feelings and viewed the experiencing of the emotions of hunger, sexual attraction, anger, etc., as the mental component of complex unconditioned reflexes. In this respect elementary emotions can be determined as the reflection and experiencing by the organism of its specific internal conditions, relating to the satisfaction of its primary needs, vital tendencies, presented by the food, protection, sexual instincts, etc., and achieved with the aid of the signal activity of the large hemispheres. By means of conditioned reflexes the emotions participate in the process of reflection, cognition and external phenomena.

The active state of the cerebral cortex requires constant support by stimuli passing from the environment and from the subcortical centers. One of such extraordinarily powerful stimuli are the emotions: raising cortical tonus, they increase the strength of the traces and transform them into actual sense images. Consequently, the first signal system is directly connected with the directive effect from two internal sources: from the leading second signal system and the subcortex. Emotions constitute the first, direct basis of sense reflection. Connecting received stimuli with primary vital

needs and endeavors by the organism, they provide a certain force of vital impression to object sensations, a feeling of reality. "A really healthy, vital thought, having a relationship to experience," said Pavlov, "takes material from actual impressions and finally from basic emotions..." (Pavlovskie Klinicheskiye Sredy /Pavlovian Clinical Environments/, vol. 2, Moscow-Leningrad, Academy of Sciences USSR Publishing House 1955, page 276; vol. I, 1954, pages 141-340).

In turn the vitally important reactions of the subcortical structures with their emotional effects are under constant regulating influence by the cortex and consequently the higher forms of the mind. Subcortical influences, including nonspecific, are subordinate to the cortex and constitute one of the mechanisms by means of which it supports its active state at a specific level. Thus consciousness should be viewed as the product of the total physiological activity of all sections of the cerebrum, each of which plays its specific part. The cortex cannot form an adequate image of an object without the essential participation of all subcortical structures. But in this large and complex orchestra the role of director belongs exclusively to it, as the highest section of the brain. The higher mental functions are inherent only to the cortex. The problem of the material substratum of mental brain activity is thus broad and complex. However, certain prominent neurophysiologists from the USA, Canada, France and other countries, in spite of the fact that they are studying chiefly one facet of the problem, have embarked on the path of one-sided exaggeration of the role of subcortical structures in their relationship to mental phenomena. Some of them have declared that the upper section of the neural tube constitutes the highest level of integrating functions in the organism, the nervous basis of consciousness: hypothesis of the centrencephalic system (Penfield, Jasper et al). This hypothesis occurred as a result of appropriate interpretation of data obtained from studying epilepsy in neuro-surgical practice. With the discovery of the nonspecific system the hypothesis of the centrencephalic system, according to the assertion of Penfield, "acquired confirmation and support" (W. Penfield, "Consciousness and Centrencephalic Organization", Congress International des Sciences neurologiques, II, page 10; same author: "Centrencephalic Integrating System", Brain, A Journal of Neurology, Vol 81, part 11, 1958, page 233).

Soviet physiologists have substantially criticized the Penfield concept. A number of foreign scientists also criticize it (Bremer, French, Leshli, Walsh, et al). In particular, Bremer, Moruzzi and other scientists believe that the reticular formation exerts a tonicizing influence on the cortex, essential for maintaining a healthy brain condition,

which essentially corresponds with the views of Pavlov on the functions of the subcortex (some foreign neurophysiologists commit a serious error by confounding the healthy condition of the cortex, which is a preliminary condition for normal state and supporting tonicizing influence by its subcortical structures, with consciousness as a mental process. This leads to an incorrect conclusion on the area of localization of the material basis of consciousness). We shall discuss the methodological side of the problem. Penfield gives the following argument for his concept: "It is quite obvious that the brain should have a central co-ordinating and integrating mechanism. If this is such a "machine" as all other machines, then there should be a place in it toward which streams of sensory impulses run. There should be a place from which streams of motor impulses emanate, in order to move both hands in a simultaneous planned action. There should be neuron chains, by means of which the activity of both hemispheres is summarized and merged in some manner -- chains the activation of which makes it possible to carry out conscious planning" (W. Penfield and L. Roberts, Speech and Brain Mechanisms, Princeton University Press, 1959, page 20).

First of all, analogy of the complex specific activity of the brain with machines cannot serve as proof in substance for the given concept. Secondly, it is incomprehensible why the cortex, constituting the most highly organized brain matter, cannot organize the activity of its hemispheres, cannot effect coordinating and integrating activity, making possible planned and purposeful reflection (research carried out in the laboratory by Kupalov [1948], demonstrated that the cortex of the large hemispheres possesses the capacity of actively regulating its general functional state, finally and accurately establishing the general level of stimulability and work capacity essential for specific external conditions, on the basis of conditioned reflex mechanisms /see Problemy fiziologii i patologii vysshey nervnoy deyatel'nosti (Problems of the Physiology and Pathology of Higher Nervous Activity), Leningrad, Medical Publishing House, 1960, pages 22-23/). One of two things is possible: either the cortex organizes its activity and the activity of the other structures and organs in the interest of the whole, or the subcortex organizes the activity of the cortex, and the cortex -- of its executory apparatus. In this case the path opens up for dualism. The presupposition that some kind of central place must exist in the brain, in which the nervous basis of consciousness is localized, doubtlessly constitutes tribute to the old, narrow localizationalism. It is true that Penfield frequently stipulates that consciousness does not

have a fixed nervous substratum. But the entire course of his argumentation runs along an opposite path. This is clearly testified to by the portrayal by him of the physical basis of mind as organizing activity, located between the intake of sensory information and volitional motor output action (viz W. Penfield, "The Role of the Temporal Cortex in Recall of Past Experience and Integration of the Present", Ciba Foundation, Symposium of the Neurological Basis of Behavior, Boston, 1958, page 149).

An adherent of subcortical psychomorphologism, Weinschenk, in an article entitled "The Seat of Consciousness", referring to Penfield and Jasper, asserts that consciousness is localized only in one section of the brain -- subcortically, in the embryonic neural tube, and that for consciousness the hemispheres of the large brain are not required (Curt Weinschenk, "Über den Sitz des Bewußtseins Psychiatrie, Neurologie und Medizinische Psychologie, Leipzig, Vol 2, 1960, pages 48, 50, 51). This viewpoint is justly qualified in the same issue of the above journal as dualism. Answering Penfield, the prominent Belgian neurophysiologist Bremer convincingly demonstrated that it is impossible to localize consciousness in any special section of the brain, in some sort of central department, acting as a state within a state (Brain Mechanisms and Consciousness, pages 497, 500).

Pavlov also spoke out against quests for a center of consciousness in some section of the brain. It follows from the teachings of Pavlov and his disciples that the physiological basis of mental phenomena is formed not of the activity of individual sections, areas and brain structures, but the entire system of the various nerve formations, functionally unified for carrying out reflexes, individual links of the mechanism of which have their seats in various sections of the brain. Not single reflexes, analyzers, lay at the basis of even elementary acts, but their unified, complex mobile functional systems (sensory, motor, etc), formed during life and expressing the integrity of reflex activity. Special functional systems merge into a general complex dynamic system, constantly striving to unify (integrate) and to stereotype the unified activity and possessing in humans a high capacity for self-regulation (Pavlov). This is the highest stage of synthetic brain activity (It is impossible to go into more detail in this article on the problem of localization of functions and the Pavlovian concept of dynamic localization, correctly considering the importance of the whole and the part).

The authors of the concept of the centrencephalic system are under the influence of the analytical approach to study of the functions of the brain and beyond the im-

portant role played by a certain section of the brain do not see the whole, that is resolve the correlation between the part and the whole non-dialectically. We should note that Penfield wavers and sometimes almost reaches the correct conclusion. Recently he has been emphasizing strongly that the embryonic neural tube and the cortex are interconnected and always act jointly. But the important thing is which element plays the leading, most important role in the cycle of these interrelationships. In spite of all of his stipulations, Penfield continues to believe that it is the centrencephalic organization which constitutes the "nervous basis of consciousness, and models of action in this organization determine, without any doubt, the nature of consciousness" (W. Penfield, "Consciousness and Centrencephalic Organization", Congress International des Sciences neurologiques, II, Bruxelles, 1957, page 13).

Consciousness is the highest form of reflection and without any doubt, the substratum of consciousness, the most complex level of integrating functions in the organism, cannot belong to the lower structures, in an evolutional respect, of the brain. This is demonstrated by experimental data in morphology, anatomy and physiology of the brain (see the compendium Nekotoryye teoreticheskiye voprosy stroyeniya i deyatel'nosti mozga /Some Theoretical Problems in the Structure and Activity of the Brain/, Moscow, Medical Publishing House, 1960). The cortex of the large hemispheres as the highest evolution of the central nervous system constitutes the most reactive part of it, possessing the most active nervous processes, the finest and most accurate capacity for analysis and synthesis, and therefore it can serve as a substratum for the higher form of reflection. "On the background of general rough activity, carried out by the subcortical centers, the cortex seems to weave the pattern of finer movements, providing the fullest correspondence with the vital situation of an animal" (Pavlov, Polnoye Sobraniye Sochineniy /Complete Works/, Vol III, book 2, page 403).

These properties of highly organized cortical matter reach their greatest development in connection with the second signal system, constituting the product of the influence of new, social stimuli. Without the leading role of the cortex human evolution would be impossible, for which acquired knowledge is of exceptional importance. It is the cortex and its functional mechanisms which carry out the functions of acquiring, non-inherited transfer and the further development of accumulated individual experience, knowledge, fixed in the language, in human behavior, given substance in the acquisitions of culture, in the entire social-historical milieu. The cortex of the large hemi-

spheres is the main carrier of social acquisition. Pavlov called it "social covering". "Man in his normal state", Pavlov said, "with the aid of the cortex regulates his behavior in accordance with the social demands of the surrounding social environment . . ." (Pavlovskie Sredy, Vol 2, page 461.)

From the viewpoint of the Penfield concept it is impossible scientifically to explain the origin and development of the nervous basis of specifically human form of expression. The Penfield concept lacks the important thing -- the social factor, the correlation between higher nervous activity of man and his social environment, his way of life. Underevaluation of the biological and social role of the brain and its higher section as an organ of communication with the surrounding world inevitably leads to an exaggeration of the role of internal factors, to isolation of the specifics of the internal mechanisms of reflection from the specifics of external stimuli, which in the final analysis can lead to a plunge to positions of "physiological" idealism.

The excessive overevaluation of the role of subcortical structures characterizes a number of other foreign works on the problem of closing conditioned reflexes (Gastaut, Fessard, Ioshii et al). Not denying the specific role of the cortex in the process of closing conditioned reflex links, Gastaut at a symposium in 1957 asserted that "subcortical structures and in particular the reticular formation of the midbrain and prosencephalon evidently play the primary role in the function of conditioned "closing", and the cortex "is introduced secondarily into play through nonspecific cortical projection systems" (H. Gastaut, "Some Aspects of the Neurophysiological Basis of Conditioned Reflex and Behavior", Ciba Foundation, Symposium of the Neurological Basis of Behavior, Boston, 1957, pages 263-255.) This "new theory of conditioned reflex activity", as it was later called by Gastaut, constitutes an open revision of the basic point of the teachings of Pavlov on higher nervous activity. Soviet scientists (Anokhin, Sarkisov, Asratyan, Rusinov, Narikashvili, Trofimov et al) after careful analysis of this theory demonstrated its lack of foundation, recognizing at the same time that the work of its representatives contains valuable factual material. A large number of foreign scientists also oppose the concept of primary closing of conditioned reflexes in the reticular formation. The teachings of Pavlov direct us not to represent a simplified conditioned reflex on the same set pattern for all cases. The conditioned reflex is of great variety both in form and level of development, multi-faceted in content, an extremely dynamic phenomenon. In the forma-

tion of conditioned links the participation of various structures of the brain differs, including that of the reticular formation. For example, "The auditory analyzer possesses more extensive capacity for closing the reflex arc within the area of the embryonic neural tube, and the optic analyzer -- within the area of the optic chiasm" (Dzugayeva, "Modern Data and Moot Questions in Teachings on the Passages of the Brain", in the compendium Nekotoryye Teoreticheskiye Voprosy Stroeniya i Deyatel'nosti Mozga, Moscow, Medical Publishing House, 1960, page 72). The error of the representatives of this concept consists in exaggerating the particular laws of closing and transformation into all-encompassing laws. The general gnoseological source of these concepts consists in a non-dialectical and primarily non-historical approach to the solution of the complex problem of interrelationships between the higher and lower sections of the brain, as well as in a non-dialectical solution to the relationship between absolute and relative truth in the progress of studies in brain activity. Discovering new facets in the functions of the brain, some experimenters have begun to deny in a relativistic manner those truths which have become solid achievements of science, have not been rejected through new research, but have merely been more accurately defined, made more specific and given new content.

Incorrect theoretical conclusions from electrophysiological experimental data have been seized by the enemies of dialectical materialism and the materialistic teachings of Pavlov. Concepts of the leading role of subcortical structures in the formation of consciousness pour water on the mill of the adherents of those reactionary idealistic views which lead the campaign against reason and place irrational, instinctive attractions in first place. At a symposium in 1953 the Freudist Kubi, having heard a paper by Penfield, stated that finally the "long delayed meeting between psychoanalysis and modern neurology and neurosurgery" had taken place (Archives of Neurology and Psychiatry, 1952, Vol 67, No 2, page 191). Factual data obtained by neurology and neurosurgery, with a correct interpretation, assail and reject psychoanalytic and analogous concepts and confirm the materialist concept of the relationship between the higher and lower forms of human mental activity.

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